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Genotype-environment Interactions for Reproduction and Maternal Performance of *Bos indicus* and *Bos taurus* Crosses in Nebraska and Florida

Larry V. Cundiff, Timothy A. Olson, K. Euclides Filho, M. Koger, W. T. Butts and, Keith E. Gregory¹

Introduction

In the U.S., cattle of diverse breeds and crosses are maintained in diverse climatic environments ranging from the temperate-continental conditions of the North Central region, characterized by wide fluctuations in temperature from winter to summer, to subtropical conditions of the Southeastern region, characterized by relatively moderate winter temperatures but high temperatures and humidity in the summer mo. The genetic range is spanned by *Bos indicus* (humped cattle) breeds, that originally evolved under tropical conditions of India and Pakistan, and by *Bos taurus* (nonhumped) breeds, that originally evolved under temperate conditions of continental Europe and the British Isles. The present experiment was conducted to investigate genotype-environment interaction for reproduction and maternal performance of *Bos indicus* x *Bos taurus* (Bi X Bt) F₁ cross cows compared to *Bos taurus* x *Bos taurus* (Bt X Bt) F₁ cross cows in a temperate (Nebraska) and a subtropical (Florida) environment. The term genotype-environment interaction applies when differences between genotypes (e.g., breeds, lines within breeds, sire progeny groups) found in one environment (e.g., climate, diet, location) change in magnitude or even rank when compared in other environments.

Procedure

This study included wt and survival data on 2,744 crossbred calves from Bt X Bt F₁ dams including Hereford X Angus and Angus X Hereford (HAX), and Pinzgauer X Angus and Pinzgauer X Hereford (PzX); and Bi X Bt F₁ dams including Brahman X Angus and Brahman X Hereford (BmX), and Sahiwal X Angus and Sahiwal X Brahman (SwX) crosses. These dams were produced in the spring of 1975 and 1976 in Cycle III of the Germplasm Evaluation (GPE) Program at MARC. The cows were progeny of Angus and Hereford dams that had been artificially inseminated to 13 Hereford, 16 Angus, 9 Pinzgauer, 17 Brahman and 6 Sahiwal (semen imported from Australia) sires.

Shortly after weaning in November of each yr, about 33% of each group of paternal half-sib heifers were transferred to the Subtropical Agricultural Research Station (ARS-USDA) at Brooksville, Florida; the other 67% remained at MARC. The heifers were maintained under standard management practices at each location. At MARC, heifers were developed on mixed silage based diets (corn silage, alfalfa haylage, and soybean meal plus antibiotics) until they were moved to cool-season pasture in April of each yr or warm season pasture from mid- to late summer. At Brooksville, heifers were maintained on permanent grass pastures (mainly Pensacola bahia grass) and supplementally fed a 20% range pellet, molasses and grass hay from November to April. At subsequent ages, the cows were maintained on

improved pastures through November, beginning in mid-March in Florida and mid-April in Nebraska. Legume or grass hay and protein supplement were fed during the winter mo at both locations.

Females at both locations were pasture mated to Red Poll bulls produced at MARC for their first calves and to upgraded (7/8) Simmental bulls produced at MARC for their second and all subsequent calves. At Nebraska, heifers were mated to produce their first calves at 2 yr of age. Due to use of earlier breeding seasons at Florida (March 15 to May 20) than at MARC (May 15 to July 20), heifers born in Nebraska and transferred to Florida did not reach puberty early enough for breeding to calve as 2-yr-olds and were bred to calves as they approached 3 yr of age. Calves were born in March and April in Nebraska and from late December through February in Florida. Calves were weaned in October in Nebraska at an avg age of 201 days and in August in Florida at an avg age of 218 days.

Data for pregnancy rate, birth wt, rate of unassisted calving, survival to weaning, age at weaning, preweaning growth rate, and weaning wt were analyzed using appropriate least squares procedures to estimate effects of location, breed group and their interaction and to adjust for effects of yr, sex, age of dam and age of calf.

Results

Breed group by location avg are shown in Table 1. The avg pregnancy rate, based on rectal palpation at or shortly after progeny were weaned each yr, was 9% higher in Nebraska than in Florida, possibly due to the nutritional environment provided and the temperate climate in Nebraska. The pregnancy rate of Bi X Bt cows was greater than that of Bt X Bt cows by 4%. The genotype-environment interaction was important for pregnancy rate ($P = .06$). The advantage of Bi X Bt cows over Bt X Bt cows for pregnancy rate was greater in Florida (6%) than it was in Nebraska (2%).

Calving ease (unassisted calving rate) was 5% greater in Florida than in Nebraska. The increased assistance in Nebraska was primarily associated with heavier birth wt (17.5 lb) in Nebraska. Most of the advantage in calving ease was observed in first calf females producing Red Poll sired progeny. Red Poll sired calves out of first calving females had a 30% higher unassisted calving rate in Florida than in Nebraska. This large location difference was likely influenced by the age of calving difference (nearly 1 yr younger in Nebraska) and the 14 lb heavier birth wt in spite of a younger age of dam in Nebraska. The genotype-environment interaction for calving ease and birth wt ease was highly significant. The advantage of Bi X Bt cows over Bt X Bt cows for unassisted calving rate was much greater in Nebraska (13%) than in Florida (4%), reflecting a similar interaction for birth wt. Birth wt of progeny of Bi X Bt cows were 10 lb lighter than those of Bt X Bt cows in Nebraska, but only 5 lb lighter in Florida where avg birth wt were relatively light for all progeny.

Calves born in Florida had a higher survival rate than those born in Nebraska (4.5%). The advantage corresponded closely to that for unassisted calving rate. Separate analyses of survival indicated that the advantage

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for the Florida location was relatively greater for Red Poll sired progeny out of first calf females (6.4%) than for Simmental sired progeny of females calving at subsequent ages (2.9%). In Nebraska, the advantage of Bi X Bt cows in calving ease was not reflected in increased survival of progeny. The survival rate in FL for Bi x Bt was only slightly higher than that of Bt X's. Possibly the advantage in survival usually associated with calving ease was offset by increased mortality associated with reduced cold tolerance (see report on mortality and cold tolerance).

The genotype-environment interaction was highly significant for preweaning avg daily gain and weaning wt. Progeny of Bt X Bt cows gained significantly faster (10%) in the temperate environment of Nebraska than they did in Florida. On the other hand, there was no significant difference between the two locations for preweaning gain or weaning wt of progeny of Bi X Bt cows. Preweaning avg daily gain of progeny of Bi X Bt cows was significantly greater than that of progeny of Bt X Bt cows at both locations; but, due to the genotype-environment interaction, the advantage of Bi X Bt cows over Bt X Bt cows was much greater in Florida (20%) than in Nebraska (8.6%).

Weaning wt per cow exposed, reflecting differences in pregnancy rate, survival rate and weaning wt of progeny, combines the most important output components of production efficiency in cow herds. Again, genotype-environment interaction was important for weaning wt per cow exposed to breeding. The advantage of Bi X Bt cows over Bt X Bt cows was much greater in Florida (28%) than in Nebraska (5.8%).

The advantage of Bi X Bt cows over Bt X Bt cows in a subtropical environment was clearly shown in this study. Adaptation to subtropical conditions is an important component of production efficiency in the southeastern U.S. Weaning wt of calves from Bi X Bt cows also equaled or exceeded those of Bt X Bt cows under temperate conditions. Part of this advantage is likely due to greater heterosis that has been found in Bi X Bt crosses than in Bt X Bt crosses. The extra heterosis is likely attributable to greater genetic diversity between *Bos indicus* and *Bos taurus* breeds than is represented between *Bos taurus* breeds. Also, the Bi X Bt cows had lower calf birth wt and calved more easily than Bt X Bt cows. However, the advantages of Bi X Bt cows over Bt X Bt cows are tempered by increased incidence of calving difficulty when Brahman sires are mated to *Bos taurus* cows, later age at puberty in *Bos indicus* sired crosses, increased calf mortality as the proportion of *Bos indicus* inheritance increases to 50% or higher under cold calving conditions, and significantly lower meat tenderness as the proportion of *Bos indicus* inheritance increases (see other articles in this report). The most effective way to manage these tradeoffs is to use crossbreeding systems or composite populations that exploit heterosis and match genetic potential in the cow herd with the climatic feed environment. Production efficiency can be increased further by making terminal crosses to the extent possible using sire breeds that reduce the *Bos indicus* influence in slaughter progeny and increase efficiency of lean tissue gain.

Table 1—Reproduction and maternal performance of *Bos taurus* X *Bos taurus* (Bt X Bt) and *Bos indicus* X *Bos taurus* (Bi X Bt) breed crosses in Nebraska (NE) and Florida (FL)^a

Trait	Location	Bt X Bt			Bi X Bt		
		HAX	PzX	avg	BmX	SwX	avg
Pregnancy rate, %	NE	92	93	93	94	95	95
	FL	83	80	82	86	89	88
Unassisted calving rate, %	NE	85	85	85	98	97	98
	FL	96	91	94	98	98	98
Birth wt, lb	NE	81	88	85	78	72	75
	FL	60	69	65	64	55	60
Survival rate, %	NE	93	92	93	91	92	92
	FL	98	94	96	98	97	98
Preweaning avg daily gain, lb	NE	2.02	2.17	2.09	2.34	2.21	2.27
	FL	1.83	1.96	1.90	2.34	2.24	2.29
Weaning wt per calf, lb	NE	498	536	518	560	529	544
	FL	437	473	455	553	523	538
Weaning wt per cow exposed, lb	NE	429	462	446	478	466	472
	FL	356	360	358	464	454	459

^a HAX = Hereford X Angus and Angus X Hereford, PzX = Pinzgauer X Angus and Pinzgauer X Hereford, BmX = Brahman X Angus and Brahman X Hereford, and SwX = Sahiwal X Angus and Sahiwal X Hereford F₁ cross cows.